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FOLIAGE SAMPLING GUIDES FOR LOBLOLLY PINE

Abstract.–Loblolly pine (*Pinus taeda* L.) trees were sampled to determine the effect of growth flush, crown position of pole trees, and winter temperature extremes upon the nutrient content of needles. Winter temperatures did not have an important influence upon elemental content. Because concentrations of several elements differed for the first, second, and third growth flush of needles, needle samples should be collected in winter months from the previous spring's first flush near the top of the tree.

The purpose of foliar analysis is to evaluate the nutrient status of trees, a variable which may or may not be related to site. With knowledge of the nutrient status of trees and knowledge of other factors which affect the site, a decision can be made concerning the possibility of site improvement.

Several choices are available when a sampling procedure for tree foliage is formulated. Season, age of needles, crown position, growth flush, and weather extremes are factors either known or expected to influence nutrient content of needles. Nutrient content variation with season, age, and crown position of 5-year-old loblolly pine (*Pinus taeda* L.) has been reported[1] and the conclusion drawn that samples should be collected in the late winter from the previous season's first growth flush at the top of the tree. It was later shown that N, P, K, Ca, and Mg contents of such samples were significantly correlated with soil test values.[2] In other work, the lack of stability in nutrient levels in fall and winter was noted and the conclusion drawn that it would not be feasible to use foliar analysis as a means of site differentiation.[3] In this latter work, nutrient instability was attributed mainly to weather factors, but the report does not make it clear that samples under comparison were always from the same growth flush.

In order to evaluate further the proposed methods and to define conditions which may influence sample content, data were tabulated for the following situations: (1) The first, second, and third needle flushes from the top of 20- to 25-foot trees were sampled in an N and K fertility study to determine effect of flush upon nutrient content; (2) needle samples from the bottom crown and the first and second flushes at the top of the crown in four pole-sized stands were analyzed to investigate crown position influence for older trees; and (3) needle samples from the same branches on 8- to 10-foot trees were compared following a cold winter period and a mild winter period to determine the effect of winter temperature extremes.

Samples were dried immediately after collection at 60° to 70° C., weighed, and ground in a Wiley mill. Nitrogen was determined by the Kjeldahl method; phosphorus by vanadomonolybdate; and Ca, Mg, Na, Mn, Fe, Zn, Cu, and Al by an atomic absorption spectrophotometer.

RESULTS

The concentration of some elements differed with flush for young and older trees (tables 1 and 2). The same effects of flush were found for all age classes. Nitrogen, P, and K were about 10 percent higher in the

[1]Wells, C. G., and Metz, L. J. Variation in nutrient content of loblolly pine needles with season, age, soil, and position on the crown. Soil Sci. Soc. Amer. Proc. 27(1): 90-93. 1963.

[2]Wells, C. G. Nutrient relationships between soils and needles of loblolly pine (*Pinus taeda*). Soil Sci. Soc. Amer. Proc. 29(5): 621-624. 1965.

[3]Miller, W. F. Annual changes in foliar nitrogen, phosphorus, and potassium levels of loblolly pine (*Pinus taeda* L.) with site, and weather factors. Plant and Soil XXIV (3): 369-378. 1966.

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second, in comparison with the first, flush of needles. A third flush of small needles at the top of the tree was observed for about two-thirds of the 10-year-old trees, but none was found on 26-year-old and older trees. Phosphorus and K percentage was consistently 12 to 13 percent higher in the small, third flush needles than in the first flush needles. Nitrogen was higher in third flush needles than in first flush needles of trees not fertilized with N and lower in the N-fertilized trees (data not shown for fertilized trees).

Needle samples can sometimes be obtained from the bottom crown of pole-sized trees when they cannot be collected from the top of the crown. For three of the four pole-sized plantations sampled, N percentage was about 10 percent higher in the bottom needles than in the first flush at the top of the trees, in agreement with results from smaller trees (table 2). The effect of crown position in pole-sized trees upon P and K was inconsistent and may have been caused by sampling error. Only one growth flush was observed at the bottom of the crown of pole-sized trees, and the age was probably about the same as the second flush of the top crown.

Temperature had no important effect upon weight or elemental content of needles from 5-year-old loblolly pine (table 3). Average temperature was 13° F. below normal the 6 days before the first sampling and 16° F. above normal for the 6 days before the second sampling. There was 0.5-inch precipitation equivalent in the form of snow and sleet during the first period and 1.10 inches of rainfall during the second period.

Analyses are often made for Ca, Mg, Mn, Fe, Zn, and Cu in samples collected for N, P, or K analysis (tables 1, 2, and 3). Deficiencies or toxicities of these elements may occur in loblolly pine, but they have not been reported in the United States. Accumulation of data on concentrations and variance of these elements will help define ranges in values and assist in

Table 1.--Nutrient content of 1st, 2nd, and 3rd needle flushes from the top of 20- to 25-foot loblolly pine trees (10 years old)[1]

Flush		Weight per fascicle	N	P	K	Ca	Mg	Mn	Fe	Zn	Cu	Al
		Grams		Percent						p. p. m.		
1	Mean	0.170	1.06	0.112	0.262	0.187	0.139	248	64	38	2.30	186
	S*	0.028	0.08	0.012	0.023	0.052	0.037	63	14	7	0.32	71
2	Mean	0.182	1.25	0.121	0.287	0.192	0.155	280	57	37	2.80	181
	S*	0.075	0.07	0.014	0.013	0.033	0.027	41	8	7	0.43	63
3	Mean	0.084	1.19	0.135	0.340	0.143	0.152	294	57	40	4.60	174
	S*	0.018	0.04	0.022	0.047	0.036	0.027	65	7	7	0.82	37

*S - Standard deviation.
[1] Each value is an average of six trees with duplicate chemical analysis.

Table 2.--Average weight and nutrient content of loblolly pine needles from bottom crown and the 1st and 2nd flushes at the top of the crown of 16 pole-sized trees[1]

Sample	Weight per fascicle	N	P	K	Ca	Mg	Mn	Fe	Zn	Cu	Al
	Grams			Percent					p. p. m.		
Bottom	0.154	1.12	0.115	0.455	0.262	0.110	805	72	36	3.1	520
Top flush 1	0.205	1.04	0.122	0.462	0.232	0.110	702	96	42	2.8	628
Top flush 2	0.186	1.14	0.117	0.442	0.249	0.126	800	97	41	3.1	592

[1] Age ranged from 26 to 32 years and height from 43 to 75 feet.

Table 3.--Change in weight and nutrient content of loblolly pine needles during a 20-day winter temperature extreme

Date sampled		Weight per fascicle	N	P	K	Ca	Mg	Mn	Fe	Zn	Cu	Al
		Grams			Percent					p.p.m.		
1-22-65	Mean	0.170	1.29	0.133	0.473	0.178	0.065	410	57	37	3.4	691
Cold	S*	0.039	0.13	0.015	0.068	0.042	0.016	124	4	6	0.4	146
2-11-65	Mean	0.166	1.33	0.133	0.479	0.190	0.069	471	58	38	3.7	685
Mild	S*	0.040	0.15	0.016	0.071	0.043	0.013	150	9	7	0.8	146
20-day increase (percent)		-2.4	3.1	-0.2	1.3	6.7	6.1	14.9	2.1	1.1	8.8	-0.9

*S - Standard deviation.

detection of unusual conditions. When more detailed study of these elements is required, data presented here will serve as background information.

CONCLUSION

Investigations of loblolly pine needle content in the North and South Carolina Piedmont suggest some general guides for sample collection, but the broad range of the species indicates a need for comparisons in other environments.

Loblolly pine needle samples should be collected in winter months from the first flush of the previous spring near the top of the tree. Winter temperature extremes do not seem to have an important influence upon elemental content. Mixing of different flushes and crown positions increases the variance and makes comparison of results between trees or plots less reliable. On pole-sized trees, when samples from the top cannot be obtained, needles from the bottom may be substituted, but the difference in sample position should be noted. Considerable range in variance in concentrations was found for the elements analyzed. As found here and in other studies, N percentage in needles is less variable than other elements, and for a given precision, fewer sample trees are required. Until the required degree of precision is determined for the different elements, it seems that 10 trees per plot will satisfactorily indicate the nutrient status of loblolly pine trees.

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